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PROCEEDINGS
BALI INTERNATIONAL SEMINAR ON SCIENCE AND TECHNOLOGY (BISSTECH) II 2014

UPN "VETERAN" JATIM

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STIKOM BALI

PROCEEDINGS

BALI INTERNATIONAL SEMINAR
ON SCIENCE AND TECHNOLOGY
(BISSTECH) II 2014

"Fundamental and Applied Research for Industrial Sustainability:
Food, Agrochemical, and Information
and Communication Technology (ICT)"

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FACULTY OF INDUSTRIAL TECHNOLOGY - UPN "VETERAN" JAWA TIMUR
STIKOM BALI

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	Method		

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SIMULATION GROWTH OF MICROORGANISMS SACCHAROMYCES CEREVISIE WITH FED-BATCH FERMENTATION PROCESS

Ni Ketut Sari[(1)], Basuki Rahmat[(2)], Awan Setyono[(3)], I Nyoman Abdi[(4)], Sutiyono[(5)]

[(1), (5)]Department of Chemical Engineering,
[(2)..(3)]Department of Chemical Informatic
UPN "Veteran" East Java, Surabaya 60295 Indonesia
[(4)]Department of Accounting
Polytechnic of Bali, Bali 80364 Indonesia

e-mail: sari_ketut@yahoo.com

Abstract

The development of the application of the science of biotechnology is not only based on biology alone, but also on other applied sciences such as computer microbiology, molecular biology, and so forth. Seeing this took researcher of issues on which the growth Sacharomyces cerevisiae yeast or yeast genus that has the ability to change glucose into alcohol and CO2 by fermentation processes. Growth of microorganisms Sacharomyces cerevisiae in the graphs form and provide information about the nature characteristics from growth of microorganisms Sacharomyces cerevisiae in fed-batch or bait-bulk fermentation process. In the graphic representation process of the growth microorganisms Saccharomyces cerevisiae, there are several stages of the process such as by inserting the initial values of the biomass concentration, initial substrate concentration entering values, enter the initial value of the broth volume, enter the value of the incoming substrate concentration during the fermentation process, and the initial value . Limit time spent in the growth graphic representation of microorganisms on the fed-batch fermentation process is 44 hours.From the simulations that have been conducted, obtained by the above chart of growth microorganisms, can be used as an overview and comparison of the actual breeding, so as to facilitate researchers in testing the breeding of microorganisms in the laboratory.

Keyword: *Saccharomyces cerevisiae, charts the growth of microorganisms, fermentation, fed-bacth.*

1. Introduction

The development of the application of the science of biotechnology is not only based on biology alone, but also in the pure sciences and applied, such as computer microbiology, molecular biology, genetics, chemistry, mathematics, and so forth. Saccharomyces cerevisiae is yeast or yeast genus has the ability to convert glucose into alcohol and CO2. Some advantages of Saccharomyces cerevisiae in the fermentation process that is rapidly proliferating microorganisms, resistant to alcohol content, resistant to room temperature, nature has held steady and rapid adaptation, several species of Saccharomyces cerevisiae capable of producing up to 13:01% ethanol, this result is better than other genus such as Candida and Trochosporon [1].
Fermentation techniques that will be used in this study is the fed-batch, fed-batch which itself is a method that adds new media on a regular basis in a closed culture, without removing the culture fluid that is in the fermenter so that the volume of the culture was increasingly growing [7]. The process of microorganisms proliferation of Saccharomyces cerevisiae fermentation with glucose as carbon source (food) given in liquid form, other variables that can affect the pH and temperature. Through the fermentation process, the proliferation of microorganisms can multiply in stages, so it takes a lot of food as well as longer periods of time. In the field of information technology science, biomass growth simulation applications that were originally developed manually then computerized.
One technique that is often used is the fermentation of bio-fermentation process for the growth of Saccharomyces cerevisiae with a bait-bulk technique (fed-batch) method in which the bait-bulk (fed-batch) itself is a new method that rnenambahkan media regularly on culture closed, without removing the culture fluid that is in the fermenter so that the volume of the culture was increasingly growing to a certain extent [7]. Based on the study's predecessor made application graphical representation Saccharomyces cerevisiae growth of microorganisms that can be used to see the growth of microorganisms from the beginning

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to the end of the time limit specified in the form of a web-based growth charts using PHP (Hypertext Preprocessor) as a scripting language, inserted into the HTML to create dynamic web.

2. Review of Literature

The flow rate of the substrate that is inserted into the fermenter is entered for growth microorganism, the process begins with the initial determination of the concentration of microorganisms, the initial concentration of the substrate in the form of glucose and substrate concentrations that fall into a certain amount during the fermentation process. The growth of the fed-batch process requires aeration with a stirrer, a pH controller and temperature controllers. The fermentation process for the growth of Saccharomyces cerevisiae is modeled by a state equation as follows [5]:

$\dot{x}(t)=f[x(t), u(t), p)+\xi(x), x(o)]= xo$ (2.1)

where x(t) = state solution at time t ($0 \le t \le T <\infty$) and $x(t) \varepsilon \Re^5$ where $\Re$ space of positive real numbers, the control signal at time t is expressed in $u_1(t)$ and $u_2(t)$, expressed as a critical parameter vector pr and the dynamics of the process are not model its exact form is not known, expressed as $\overline{\xi_1}$ dand $\overline{\xi_2}$. Process starts at time t = and ends at time T, where T is generally of the order of hours or days. In this study, T is assumed to be 44 hours. Mathematical model for the fed-batch fermentation of Saccharomyces cerevisiae is growth, described using the following differential equation [5]:

$$\dot{x_1} = \mu_m \frac{x_1 x_2}{k_s + x_2} \frac{1}{1+x_3^2} - \frac{x_1}{x_5} u_1 + 0.48 x_1 \overline{\xi_1}(x) \quad (2.2)$$

$$\dot{x_2} = -\frac{\mu_m}{k_y} \frac{x_1 x_2}{k_s + x_2 1 + x_3^2} \frac{1}{1+x_3^2} + \frac{u_2 - x_2}{x_5} u_1 - k_m x_1 - \frac{1}{0.51} x_1 \overline{\xi_2}(x) \quad (2.3)$$

$$\dot{x_3} = 0.0023 x_1 + 0.007 \mu_m \frac{x_1 x_2}{k_s + x_2} \frac{1}{1+x_3^2} - \frac{x_3}{x_5} u_1 \quad (2.4)$$

$$\dot{x_4} = x_1 [\overline{\xi_2}(x) - \overline{\xi_1}(x)] - \frac{x_4}{x_5} u_1 \quad (2.5)$$

$$\dot{x_5} = u_1, \quad (2.6)$$

Where,

x_1 = concentration of microorganisms (biomass)

x_2 = concentration of substrate

x_3 = concentration of inhibitor (inhibitory substance)

x_4 = Concentration of ethanol

x_5 = Volume broth

u_1 = substrate flow rate

u_2 = concentration of the incoming substrate

$\overline{\xi_1}$ = Magnitude related to ethanol consumption

$\overline{\xi_2}$ = Quantities related to the rate formation ethanol

From the above formula is written as a critical process parameters: μ_m, k_s, k_y and k_m assumed as elements of a vector parameter p_r ($p_r = [\mu_m, k_s, k_y, k_m]^T$). Formula used to determine the parameter vector pr is assumed to vary with time as follows [5]:

$\mu_m(t) = 0.41 + 0.01 \cos(\frac{2}{5}\pi t)$ (2.7)

$k_s(t) = 0.03 - 0.005 \cos(\frac{2}{15}\pi t)$ (2.8)

$k_y(t) = 0.4 + 0.1 \cos(\frac{2}{10}\pi t)$ (2.9)

$k_m(t) = 0.04 - 0.01 \cos(\frac{2}{20}\pi t)$ (2.10)

In a qualitative relationship, the purpose of control is to determine u1 (t) and u2 (t) to maximize biomass production on interfal [0,T] for assurance that $x_4(t)$ concentration of ethanol, which has the effect of removing the final product is low. The second difficulty is the control problems that are caused by the nonlinear state of the plant and by the emergence of dynamics not termodelkan ($\overline{\xi_1}$ (.) and $\overline{\xi_2}$ (.) can be resolved. The problem can be increased in accordance with the fact that the values of the parameters (the elements of pr) may be unknown and the initial value x0 may be different from the desired initial conditions x_{0*}. Dinamika tak termodelkan yang bersifat nonlinier, $\overline{\xi_1}$ (.) and $\overline{\xi_2}$ (.) as described above are each associated with ethanol consumption and ethanol formation rate. Based on a common known fact that ethanol production is formed after the value of the substrate concentrationx_2 * terlampui, informasi sebelumnya mengenai $\overline{\xi_1}$ (.) and $\overline{\xi_2}$ (.) known [5]. From the description above it is known that some problems arise when the dynamics is not models $x_2(t)$ is greater than the critical value. As it has been used by [5], for the process was discussed x_2 * = 0,28. Where as if u_2 * = 200, vector parameters chosen as p = p* = [0.52 0.025 0.5 0.03] ^{T} and the initial value of the state vector chosen as x(0) = x*(0) = [10 0.28 0 0 10] ^{T} then the resulting trajectory of the state x(t) (write as x*(t)) performasi showed satisfactory process. The process described using the equation (2.2)-(2.6) dengan p = p*, x(0) = x*(0), u_2* = 200 and

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$$U_1(t) = u_1^*(t) = \frac{x_3^*(t)}{200 - x_3^*(t)} \left[0.03 x_1^*(t) + \frac{0.42}{0.5} \frac{x_1(t)\, x_2^*(t)}{0.025 + x_2^*(t)} \frac{1}{1 + x_2^*(t)}\right] \quad (2.11)$$

Referred to as the nominal models. Variables and parameters with an asterisk stating that the corresponding nominal value, and the system is said to be operated in the nominal regime. Website or the site can be defined as a collection of pages that are used to display text information, still or motion picture, animation, sound, and or a combination of these, both static and dynamic form of a series of interconnected buildings, each of which connected to the networks page [2].

PHP: Hypertext Preprocessor is a programming language that is widely used for handling the manufacture and development of a website and php script can be implanted or inserted into the HTML. PHP is widely used to program dynamic web sites. PHP can be used to build a CMS. Integer data type is a data type that is useful for storing negative and positive integers, and not without a decimal or fractional value. This type can also be expressed in the form of an octal (base 8), decimal (base 10), hexadecimal (base 16). Object data type created with the aim that the programmer familiar with OOP, object data type can be a number, a variable or function, data can be inserted into program code that summarizes some of the functions and reduce the file size. Array or an Array of Primitive Types Compound, found in other programming languages. Array data type is used to store a lot of data in a single variable. Null is a data type that can not load anything, how to set the variable to null is to insert a null value to the variable in question. A special data type that is devoted to saving resource, source or address. These variables can only be created by a special function that returns the value of a resource such as the use opendir function, mysql_connect, mysql_query and the like [4]

Data flow diagram (DFD) is a diagram that uses notasi- notation to describe the flow of the system. DFD is often used to describe sustu existing system or a new system that will be developed logically without considering the physical environment in which the data flows (eg by telephone, letter, etc.) or the physical environment in which the data is stored in a file card, hard drive, tape, diskette [6].

CDM or Conceptual Data Model is a model that is based on the assumption that the real world consists of a collection of basic objects called entities (entities) and relationships (relationship) between the entities. CDM is usually represented in the form of an Entity Relationship Diagram. While PDM or phsical also called data model is a model that uses a table to describe the data as well as the relationship between these data. Each table has a number of columns where each column has a unique name. In making a good application, a database design is usually done first. Using a data conceptual modeling, the database that will be made will be seen more clearly grooves and picture [3].

3. Research Methodology

In the graphic representation of the growth of microorganisms, substrate flow rate incorporated into the fermenter equipped with tools to control the growth of microorganisms. The process begins with the initial data entry of biomass concentration, substrate concentration and the initial concentration of substrate, such as glucose in a certain amount, then menentuan initial value of the volume and value of miu broth, ks, km, ky. The growth of the fed-bacth process is also influenced by earasi with a stirrer, a pH controller and temperature controller. System design graphic depiction of the growth of microorganisms Saccharomyces cerevisiae in fed-batch fermentation process is described in the flowchart in Figure 3.1 bel

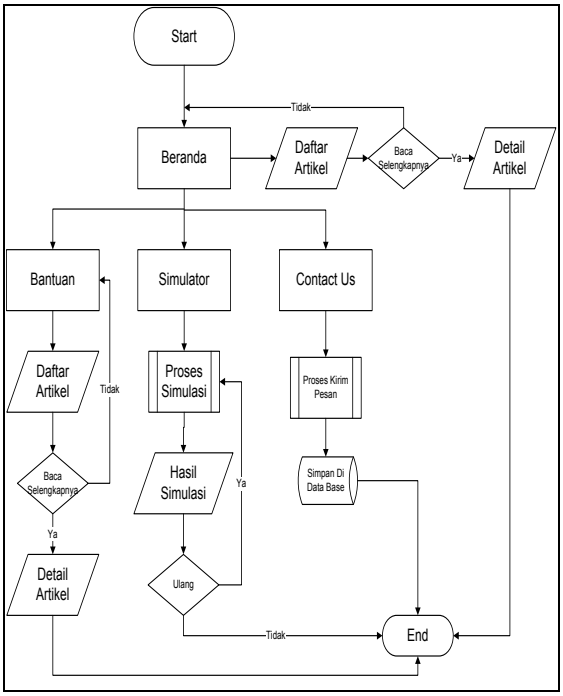

Figure 3.1 Flowchart depiction Systems Growth Charts.

Mikroorganisme *Saccharomyces cerevisiae* In the picture above when the user access the web user will immediately be on the home page which is the beginning of the web page. Then the user can choose an existing category like reading an article that has been provided by the admin of the microorganism in question and an explanation of the techniques used in the fermentation of Saccharomyces cerevisiae growth of microorganisms. Users also can use the graphic representation of the growth of microorganisms Saccharomyces cerevisiae are provided on the simulator menu, by entering some initial values of the factors needed growth of microorganisms and after the application is processed by the system user to get the results of calculation of the growth chart and its influential factors. user can also send criticism or suggestions as well as questions regarding the application graphical representation of growth of microorganisms Saccharomyces cerevisiae contact us page of which has been provided.

4. Results and Discussion

After the user enter the start and mesakkan value in the program, immediately perform calculations automatically and display the results of a calculation in the form of line graphs highchart.

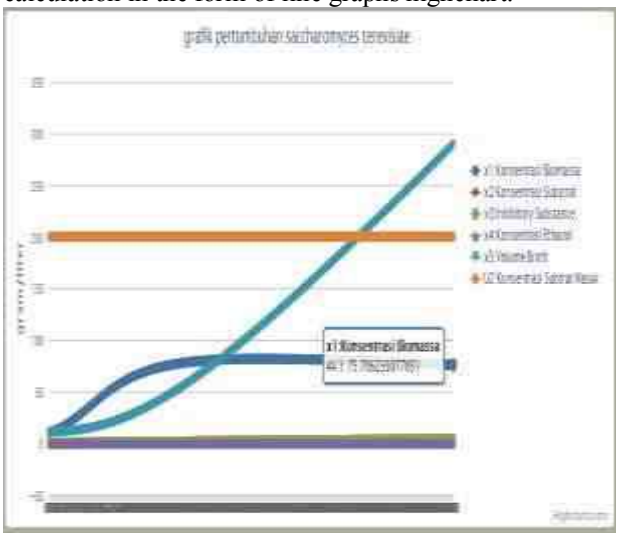

Figure 4.1 Graph Results of the First Experiment

In the graph it can be seen the development of biomass concentration at the time of 44.1 to 75 g / l from an initial value of 10 g / l and has the highest value for 81gr / l at the 23rd hour later entering the substrate concentration was fixed 200 g / l to the time limit for the experiment. The volume of broth which initially has a value of 10 g / l continues to increase until the end of the time limit of up to 288 g / l which indicates an increase in volume in the fermenter as a result of increased concentrations of biomass and substrate concentrations were entered.

5. Conclusion

a. System is a graphical representation of web-based microorganism growth can help to illustrate the graph corresponding user enter the initial value, there are several articles on microorganisms Saccharomyces cerevisiae and some fermentation techniques as well as the usefulness and benefits.
b. Designing a graphical representation of growth of microorganisms can be used as an overview and comparison of the actual breeding, so as to facilitate researchers in testing the breeding of microorganisms in the laboratory.

6. Daftar Pustaka

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